Coastal Heritage

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Water's Edge

Managing Coastal Runoff

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ON THE COVER:

Spartina alterniflora, *the common salt marsh grass, absorbs contaminants and prevents erosion along many Kiawah Island pond shorelines.*

PHOTO/GRACE BEAHM

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Science Serving South Carolina's Coast

Coastal Heritage is a quarterly publication of the S.C. Sea Grant Consortium, a university-based network supporting research, education, and outreach to conserve coastal resources and enhance economic opportunity for the people of South Carolina. Comments regarding this or future issues of ***Coastal Heritage*** are welcomed at John.Tibbetts@scseagrant.org. Subscriptions are free upon request by contacting:

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NUTRIENT CLEANSE. *Norm Shea, director of lakes management for the Kiawah Island Community Association, encourages property owners to plant water-filtering* Spartina alterniflora *along pond edges.*
PHOTO/GRACE BEAHM

Water's Edge

Managing Coastal Runoff

by John H. Tibbetts

Kiawah Island is luxuriously quiet in the winter off-season. Golf links and walking paths are nearly empty. When the wind dies down and the tide goes slack, the island's ponds turn smooth as glass.

Norm Shea pauses on the narrow wooden footbridge over four-acre Turtle Beach Pond. Although surrounded by million-dollar homes, it's a calm retreat where an egret feeds in the shallows.

Spartina alterniflora, the common salt-marsh grass, flourishes along the shoreline.

"We've pushed the idea that it's not a good idea to have lawns right down to the pond edge," says Shea, director of lakes management for Kiawah Island Community Association. "If you have [wetland plants] along the shoreline, the pond will look better and your shoreline will stay in place. Property owners have a vested interest in keeping a pond and shoreline healthy."

At Kiawah Island, 25 miles southeast of Charleston, S.C., the Kiawah Island Community Association and individual property owners began cultivating *Spartina* along pond edges several years ago. They hoped this aquatic grass would capture and cleanse excess nutrients in chemical fertilizers and organic matter—grass clippings, leaf litter, pet and wildlife waste— that wash off lawns, golf courses, and roads when it rains.

Stormwater runoff pours into roadside catch basins, and then is routed through subterranean pipes, and finally discharged, unfiltered, into ponds.

On warm summer days, many ponds in coastal South Carolina become murky soups of excess nutrients and other pollutants that can stimulate algal blooms, some of which release toxins or cause low-oxygen conditions, killing fish.

Developers traditionally dig ponds to capture this runoff for a time. A typical detention pond has storage space for stormwater between the pond's surface and the bottom of the outflow pipe. Depending on the site, a pond is designed to hold the first

MANICURED. *The great majority of pond shorelines in coastal South Carolina have closely cropped lawns that allow runoff pollution to enter the ponds.*
PHOTO/GRACE BEAHM

half-inch or inch of stormwater for 24 hours before discharging it into creeks and rivers. The problem is that excess nutrients and other harmful contaminants are often discharged without treatment into waterways.

One of the simplest ways to improve water quality in ponds is to cultivate wetland plants along their perimeters. Indeed, each detention pond should have a "bench" of wetland plants along its shoreline to absorb pollutants, according to a comprehensive 2009 National Research Council report on the nation's stormwater management.

About 60% of the Kiawah Island ponds now have *Spartina* growing along their shorelines. Still, a large fraction of property owners don't want wetland plants. "They think it looks unkempt," says Shea. "Too snake-y looking."

Very few ponds elsewhere in coastal South Carolina include these wetland features. Instead, the great majority of pond shorelines are aggressively manicured with lawn grass cropped to the nub.

Still, there is a growing scientific consensus that existing stormwater ponds should be retrofitted with wetland-plant borders or with other water-filtration methods.

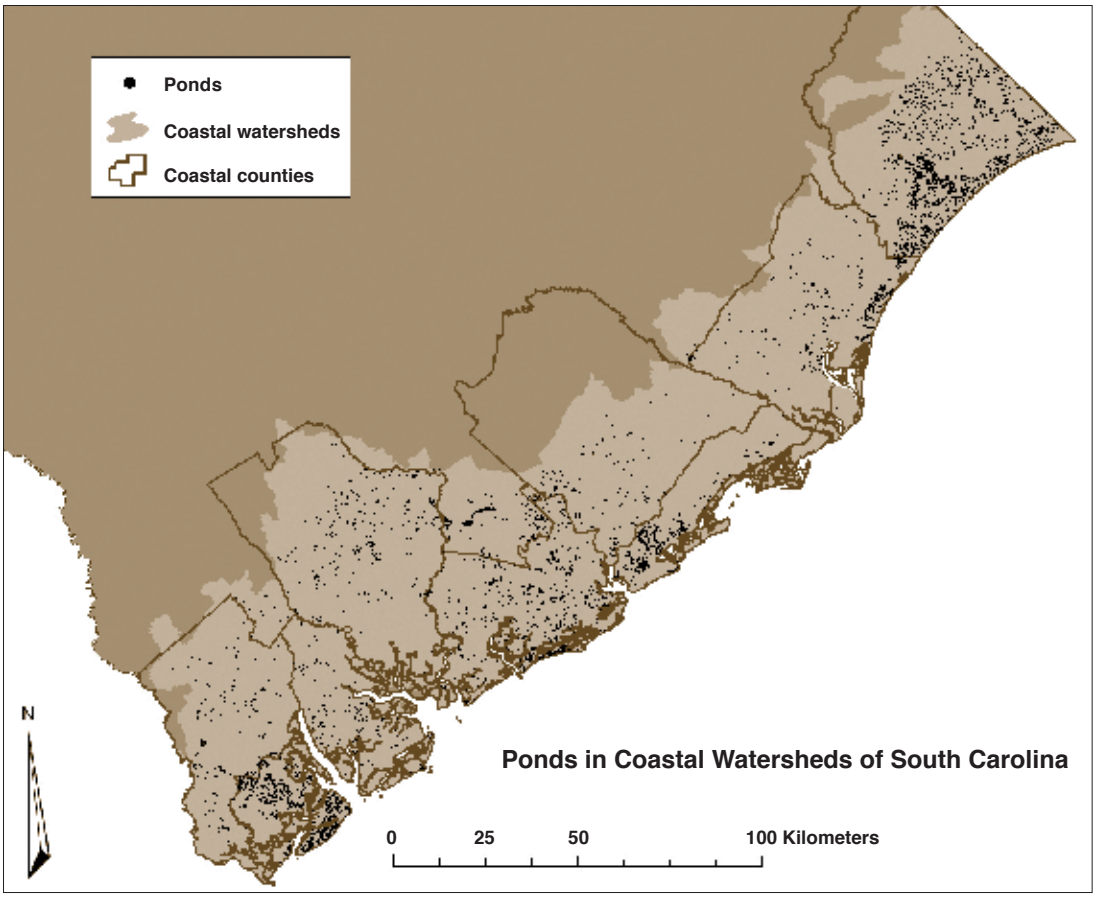
That, however, would be a tall order. Over the past three decades, federal flood insurance, mosquito control, air conditioning, drainage projects, and improved building practices (such as elevating structures on tall pilings) have allowed an exploding population to move to South Carolina's flat, often soggy coastal region where managing stormwater is a particularly difficult task.

More than 14,000 ponds have been dug in the uplands of South Carolina's coastal region since the 1970s, according to Sea Grant researcher Erik Smith, an aquatic ecologist with the University of South Carolina and the North Inlet–Winyah Bay National Estuarine Research Reserve in Georgetown, S.C. (This number doesn't include old rice fields and other ponds carved out of wetlands and managed for hunting waterfowl.)

The distribution of stormwater ponds along the coastal zone is highly uneven and tends to follow the pattern of development. In some areas, ponds can comprise up to 5% of the total watershed area. At the scale of individual developments, however, the percentage can be more dramatic, with upwards of one-third of the landscape being converted to artificial ponds.

"Ponds represent a new type of aquatic environment along South

WASHED AWAY. *This pond edge in Horry County has slumped into the water. Planting a border of* Spartina alterniflora *or other wetland plants could help protect it from further erosion.*
PHOTO/BEN POWELL/CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE



Each dot in this map represents one pond in the upland area of South Carolina coastal watersheds. More than 14,000 ponds have been dug in this region, the overwhelming majority for the purpose of stormwater management.
MAP/ERIK SMITH/UNIVERSITY OF SOUTH CAROLINA AND NORTH INLET-WINYAH BAY NATIONAL ESTUARINE RESEARCH RESERVE

Carolina's coastal zone," says Smith. "They didn't naturally exist in these locations. We have essentially re-plumbed this region by digging a whole lot of shallow bathtubs that eventually drain to nearby waterways. Some of these ponds develop in healthy ways, mimicking natural water bodies where fish and wildlife thrive. Many others become ecologically dysfunctional. Either way, these ponds are changing how runoff from the uplands enters into, and interacts with, coastal waters—with implications for coastal water quality that scientists don't fully understand."

IMITATING NATURAL PROCESSES

For thousands of years, vast tracts of pine and hardwood forests provided the water-filtration system for coastal South Carolina's aquifers, rivers, and estuaries—a system that modern development has found very difficult to replace.

About 52 inches of precipitation falls annually on the South Carolina coastal plain. Mature trees store and transpire up to 85% of the water flow in a forest in the South Carolina coastal plain during a dry period, and 50% during a wet period, according to studies by the U.S. Department of Agriculture Forest Service's experimental forest in the Francis Marion National Forest. Trees release rainfall back into the atmosphere instead of shunting it into water bodies.

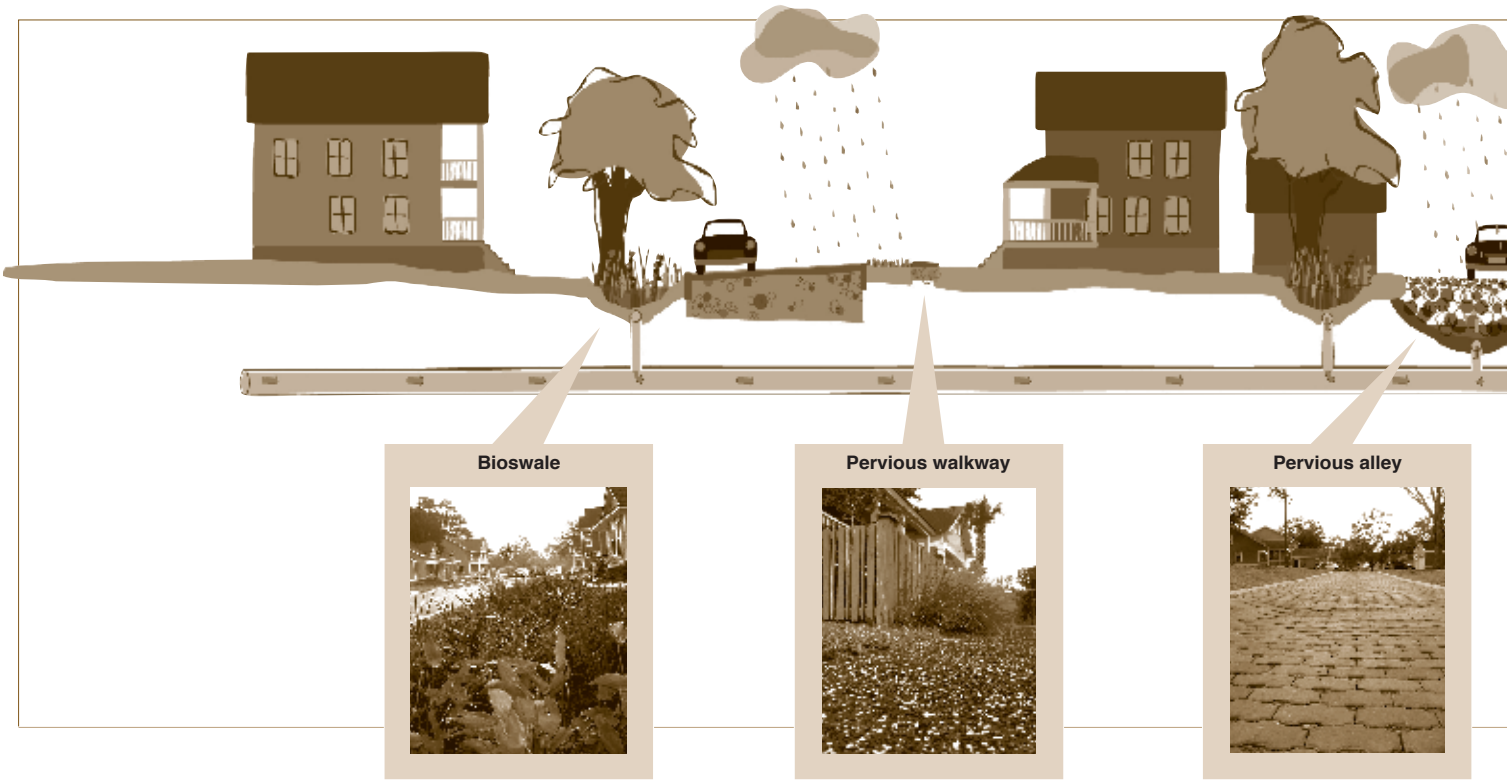
It's especially important to save mature trees on a development site. "A tree is a stormwater-management machine," says Randy Greer, an engineer with Delaware's Division of Watershed Stewardship.

Rainwater also filters into the subsurface where soils and beneficial microbes cleanse it. Over time, it gravitates to recharge an aquifer, or seeps downslope into rivers, lakes, salt marshes, or the ocean.

And, finally, some rainwater flows across the forest floor, cleansed by soils and vegetation, or it flows through the shallow subsurface into waterways.

In a conventional modern development, by contrast, the water cycle is radically simplified. Developers cut down water-absorbing trees and other vegetation, compact soils with heavy backhoes and trucks, and lay down new sod or grass seedlings, which are irrigated and fertilized for lawns and golf courses until they become intense shades of green. Rainwater captures this nutrient-rich runoff and carries it into stormwater ponds, where it can reduce downstream flooding but enhance nutrient levels that goose algal growth.

To build roads, driveways, and parking lots, developers cover the ground with dense—or impervious—pavements. Conventional pavements are manufactured with fine materials of various sizes that fit together snugly, making them strong and durable, and allowing them to bear heavy use. But these "tight" materials don't allow rainfall to penetrate and reach soils and microbes in the subsurface. The



water-cleansing and water-absorbing functions of forestlands are lost as a result.

Rainwater has to go somewhere when it hits the surface. If rain falls on an impervious surface, it flows downslope, gathering volume and speed, capturing oil, grease, sediment, pesticides, heavy metals, nutrients, and other contaminants along the way. Most of this stormwater is routed into detention ponds.

The volume of water running off an acre of impervious pavement is 10 to 20 times greater than that from an acre of grass, according to numerous studies. Stormwater also runs faster across impervious surfaces than across natural areas.

Adding impervious surfaces to just one-tenth of a watershed's acreage increases runoff that begins to impair the biological health of local streams, according to scientists.

Says Erik Smith, "With conventional development, we have reduced the filtering and absorbing capacity of natural areas while we have also created a potential new source of water contamination in the form of ponds that discharge into adjacent marshes, creeks, rivers, and beachfronts."

LOW-IMPACT DEVELOPMENT

Many scientists, regulators, innovative developers, engineers, and others are calling for eco-friendly techniques that would capture greater volumes of rainwater and filter more contaminants than conventional systems do.

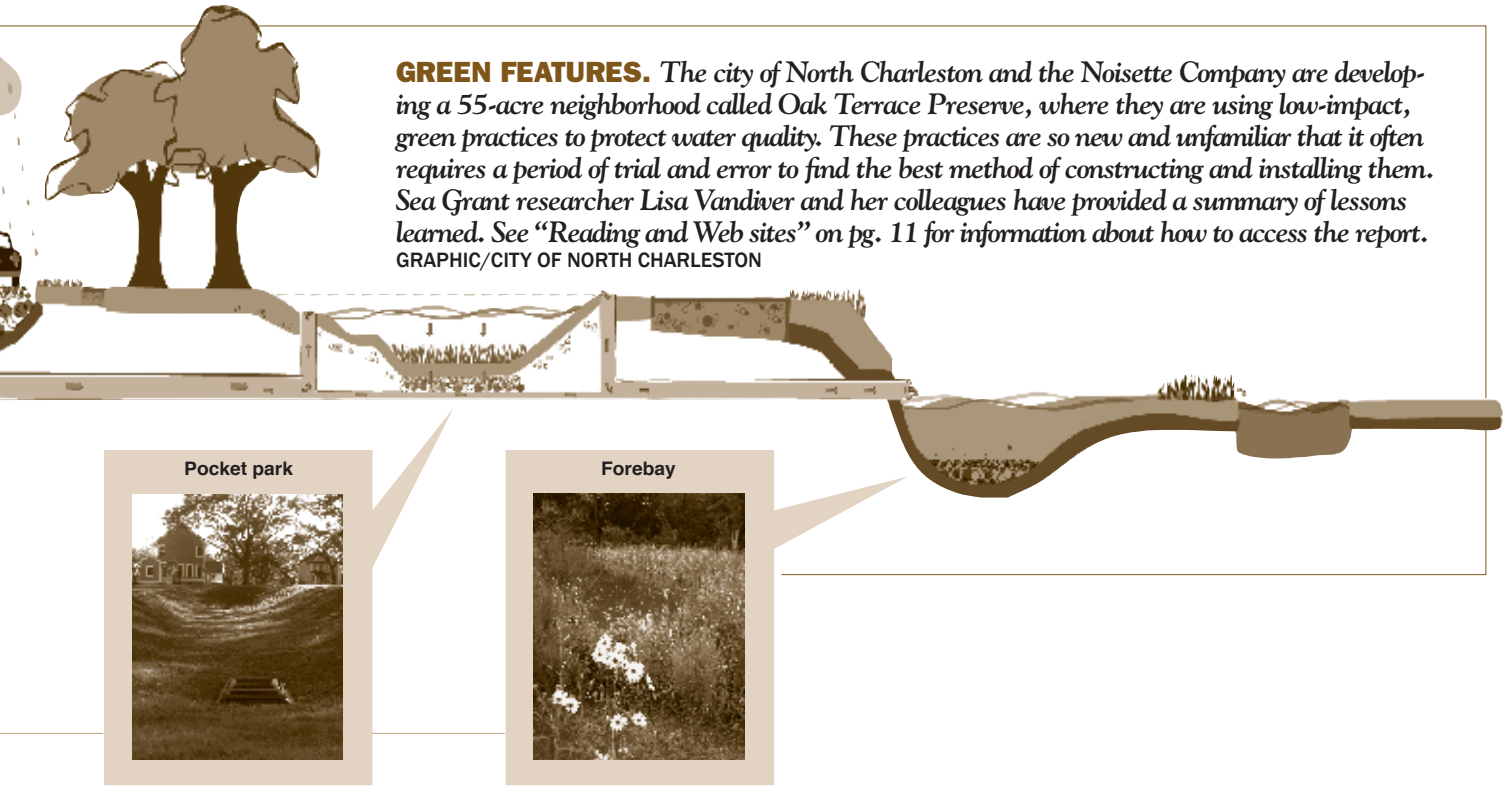
The idea is that runoff should be treated on-site along its entire route from roofs and lawns to streets to subterranean pipes to detention ponds to estuaries. At each stage, plants, soils, and beneficial microbes could absorb and filter rainwater.

For years, the U.S. Environmental Protection Agency (EPA) has been promoting "low-impact development" (LID) or "green infrastructure" practices that mimic, as much as possible, the natural hydrology of the pre-development environment.

EPA is writing new federal stormwater regulations, due to be enacted in November 2012, and the agency is likely to push for more use of LID practices, which include:

- Building shallow "bioretention" projects such as rain gardens, bioswales, and pocket parks that absorb stormwater and use vegetation, soils, and microbes to filter pollutants.
- Installing rain barrels and cisterns that capture rainwater, and reorienting gutter downspouts to send water into bioretention features instead of onto pavements.
- Installing porous pavement that allows runoff to infiltrate into the subsoil where cleansing can occur.
- Protecting or creating terrestrial vegetated buffers along waterways.
- Adding water-filtering plant species along shorelines of stormwater ponds.
- Preserving large natural areas with outright purchases or acquiring conservation easements that limit development there.
- Requiring that developers build on only select portions of a site to protect water-absorbing trees and other plants.
- Last but not least, building new stormwater wetlands.

In contrast to stormwater ponds



GREEN FEATURES. *The city of North Charleston and the Noisette Company are developing a 55-acre neighborhood called Oak Terrace Preserve, where they are using low-impact, green practices to protect water quality. These practices are so new and unfamiliar that it often requires a period of trial and error to find the best method of constructing and installing them. Sea Grant researcher Lisa Vandiver and her colleagues have provided a summary of lessons learned. See "Reading and Web sites" on pg. 11 for information about how to access the report.*
GRAPHIC/CITY OF NORTH CHARLESTON

built on the South Carolina coast, created wetlands are dry or boggy much of the year but can fill with water during wet periods. Aquatic plants, including *Spartina* in brackish areas, are cultivated as contaminant filters.

Numerous localities nationwide have incorporated LID practices into local codes, ordinances, regulations, and stormwater-management plans.

In coastal South Carolina, three communities—a green neighborhood called Oak Terrace Preserve in North Charleston, the town of Bluffton in Beaufort County, and Beaufort County itself—have required developers to install various low-impact technologies, although state regulations do not require LID methods to be used.

But relatively few contractors in coastal South Carolina know how to install these new green technologies, and many local regulators are unfamiliar with them. There are still questions about LID performance, construction, and maintenance, particularly in the coastal zone.

LID practices, originally designed for piedmont conditions, have been proven effective on sites with some topographical relief, soils that allow infiltration, and deep water tables.

Not long ago, many sites fit that bill in coastal South Carolina. But not anymore. Nearly all of those places have already been developed, says Betty L. Niermann, division head of civil engineering at Seamon Whiteside and Associates in Mt. Pleasant, S.C. Developers are now considering building on "less-desirable sites that they walked away from 10 years ago," Niermann says.

Shannon Hicks is manager of stormwater and state certification at the S.C. Department of Health and Environmental Control–Office of Ocean and Coastal Resource Management. "Definitely," Hicks says, "we see more [permit applications] coming in for sites that have additional constraints."

Less-desirable sites tend to be flood-prone, having low elevations, scant topographical relief, permanent or seasonally high water tables, "flashy" or "tight" clay soils that inhibit rainwater infiltration, and constraints on developable space because of potential impacts on wetlands, historic sites, and other resources.

Under natural conditions, coastal South Carolina is susceptible to flooding. During its typically wet winters, the water table is close to the surface in many locations, and soils and trees become saturated with rainwater. When rain falls on waterlogged landscapes, it runs off quickly, swelling creeks and rivers. When new developments with impervious surfaces such as roofs and conventional pavements are added to a site, flooding risks increase dramatically.

The traditional answer to flood management is to build detention ponds. If ponds are well-designed, well-built, and maintained, they offer a proven method to reduce peak flooding during storms. Many LID practices, by contrast, do not have a record in coastal-plain regions with high annual rainfall.

"LID [practices] aren't enough to prevent flooding issues in a 10-year storm event with six and a half inches of rainfall," says Fowler Del Porto, a senior engineer project manager with the city of Charleston. "Obviously, we'd like to see more LID [practices], but

MOCK LANDSCAPE. *The clubhouse at Bulls Bay Golf Club stands on an artificial hill. After digging holes for ponds, a developer can use the dirt to raise land elevation for homes and other structures.*
PHOTO/GRACE BEAHM

they are not going to replace ponds."

Ponds do retain some contaminants (sediments and heavy metals, for instance) in particles that gravity draws to the mucky bottom and holds there, preventing them from being discharged into waterways, according to Sea Grant researcher John Weinstein, an aquatic toxicologist at The Citadel. Over time, however, ponds fill in with bottom gunk and need dredging to remain effective.

Conventional stormwater ponds, meanwhile, tend to collect and concentrate nutrients in the water column. Nutrients, such as nitrogen and phosphorus, are necessary for aquatic life, but when they accumulate in excess they can stimulate algal blooms that sometimes deplete dissolved-oxygen levels. Some algal blooms lead to degraded water quality, and certain types of blooms can cause fish kills. There are toxin-producing algal blooms that can pose health risks to people, pets, and wildlife.

Although primarily designed for stormwater management, these ponds are often used for fishing, crabbing, boating, kayaking, and even swimming. In the past several years there have been no documented human-health effects in people who have come into contact with harmful algae in South Carolina stormwater ponds.

Joe Fersner, a former coastal regulator and now a civil engineer with Woolpert, Inc., in its Mt. Pleasant, S.C., office, says, "Ponds have been the easiest mechanism" for builders to meet stormwater requirements when building on previously undeveloped locations, "although they might not be the best method for protecting water quality."

Denise Sanger, assistant director for research and planning with the S.C. Sea Grant Consortium, says, "We have asked ponds to be the end-all and be-all of South Carolina's stormwater management. But we shouldn't expect one practice to solve all of the flooding and water-quality problems associated with stormwater. We need a combination of measures to achieve success."

PROLIFERATING PONDS

It was during the 1960s that many northerners discovered coastal South Carolina as a resort-and-retirement location. Wide, sandy beaches were an early attraction for tourists and retirees. Oceanfront parcels, though, became too expensive for all but the wealthiest people looking to buy or build a home.

Still, many homebuyers were willing to spend large sums to live near any sort of water body. Builders constructed thousands of second homes, retirement homes, and vacation condominiums along waterfronts of South Carolina's tidal creeks, estuaries, and coastal rivers.

In the mid-1970s, Kiawah Island was one of the first communities in coastal South Carolina to dig dozens of ponds to attract potential homebuyers. The vast majority of Kiawah Island ponds were built from 1975 to 1990, primarily as amenities. (Norm Shea calls these water bodies "lakes" while the resort island's sales agents call them "lagoons" and scientists usually call them "ponds.")

Today, each Kiawah Island lot with a lagoon view commands a market premium. Even the smallest lagoon on the island—just one-tenth of an acre—creates a waterfront parcel. Kiawah Islanders who live along ponds say they especially enjoy watching waterbirds alight and feed there.

Other coastal developers have since dug ponds to manage stormwater but also to create waterfront parcels. For example, along the Waccamaw Neck and Grand Strand region of South Carolina, the number of ponds increased by 90% during the period from 1994 to 2006, according to Erik Smith.

During real-estate booms, it was common to see newspaper advertisements for new neighborhoods featuring "recreational ponds," complete with photos of beaming young families or pink-cheeked retirees. Indeed, some developers build many more ponds than are actually needed to manage stormwater, according to Sadie Drescher of the Center for Watershed Protection in Ellicott City, Md.

Developers also build detention ponds for the dirt they produce. Dirt, it

turns out, isn't cheap. After digging a hole for a pond, a developer can use that fill material to lift a nearby site's elevation, saving money that would otherwise be spent on finding and transporting dirt from miles away.

Detention ponds, then, serve a number of purposes. But their greatest advantage for many developers and residents is that they "create habitats or picturesque settings" while managing stormwater, the National Research Council report points out. A major disadvantage is that "they often have limited treatment capacity, in that they can reduce pollutants only to a certain level."

HARMFUL ALGAL BLOOMS

Some stormwater ponds provide almost ideal conditions for harmful algae that can produce toxins or have other environmental-health impacts. From 2001 to 2005, more than 200 harmful algal blooms from 23 different species were documented in South Carolina coastal detention ponds, brackish or freshwater, from Georgetown County south to Beaufort County.

Many of these algal blooms were associated with measured toxins, fish kills, or shellfish health effects, according to a 2008 study published in the *Harmful Algae* journal by Sea Grant researcher Alan J. Lewitus, former director of the S.C. Algal Ecology Laboratory (SCAEL), a joint effort of the University of South Carolina and S.C. Department of Natural Resources. Lewitus is now a branch chief with the National Oceanic and Atmospheric Administration Center for Sponsored Coastal Ocean Research.

Some of these blooms occurred at Kiawah Island. In fact, the first comprehensive studies of harmful algal blooms in South Carolina's coastal stormwater ponds began a decade ago on Kiawah Island with Sea Grant support. In 2001-2002, Lewitus and his colleagues found widespread instances of potentially or measurably toxic harmful algal blooms there. (These data were included in the 2008 Lewitus study.)

"It was definitely a surprising finding, and very disturbing for us," says Norm Shea of the Kiawah Island Community Association.

Kiawah Island is one of the last resort islands you'd imagine having such problems. In the 1970s, island developers were years ahead of their time in sustainable development practices, including protecting wildlife and local ecology.

Since 2002, SCAEL researchers have partnered with Shea to measure selected Kiawah Island ponds for water temperature, salinity, dissolved oxygen, and pH. Water samples are also collected to identify composition of phytoplankton communities and to note any toxins in 19 ponds that scientists consider representative of

POND STEW. ***Excess nutrients in ponds can stimulate algal blooms such as this one at Magnolia Cemetery in Charleston, South Carolina.***
PHOTO/GRACE BEAHM

the pond system on the island.

If toxins are present, island-wide warnings are issued.

"Kiawah Island really does a very conscientious job of managing its ponds," says Sea Grant researcher Dianne Greenfield, current director of SCAEL. "We have had a productive relationship with them." Greenfield and other scientists continue to study Kiawah Island's water quality and nutrient impacts on pond algae.

Meanwhile, Shea and his staff fight harmful algae by spraying herbicides, stocking ponds with tilapia and other fish that consume algae, and educating homeowners, landscaping companies, and island maintenance staff about preserving pond buffers and keeping grass clippings and other nutrient sources out of the water.

"We're trying to do everything we can to reduce nutrients," says Shea. "But conditions in these stormwater ponds are really ideal for the growth of algae. And we definitely don't want to export any water-quality problems" into creeks and salt marshes.

NATURE'S FILTER. *Wetland plants and soils soak up contaminants in a constructed wetland, like this one at Mary Bridges Park in Wilmington, North Carolina.*
PHOTO/CENTER FOR WATERSHED PROTECTION

CREATING WETLANDS

It's clear that many more stormwater ponds will be constructed along the South Carolina coast, adding to the 14,000 ponds already there.

Sea Grant researcher Daniel Hitchcock, a biosystems engineer with Clemson University, says, "There might be too much of a flooding potential to stop using ponds completely in the coastal region. But you could

What can you do?

You can play a role in reducing stormwater impacts. Limit your load of pollutants through these activities:

- Apply fertilizers and pesticides sparingly and according to directions, and be careful not to apply before rain events.
- Reduce bacteria by picking up after pets and disposing of the pet waste appropriately. If your home is on a public sewer system, flush pet waste down the toilet. Other options include disposal in household garbage or burial in your yard at least six inches deep and away from vegetable gardens and waterways.
- Wash your car on your lawn (or other porous areas) where the chemicals can be absorbed into the soil rather than draining into the nearest creek or pond.
- Dispose of lawn clippings in a compost pile.
- Harvest rooftop rainwater through rain barrels or rain gardens.
- Take paint, oil, antifreeze, debris, or other chemicals to a county recycling center.
- Preserve mature trees.
- Clean up spilled brake fluid, oil, grease, and antifreeze. Do not hose them into the street where they can eventually reach local waterways. Take to a county recycling center.
- Maintain proper septic system function with inspections and pump-outs every three to five years.

still reduce over-reliance on ponds by using site-specific solutions—adding constructed wetlands or pervious pavers or protecting trees—that provide infiltration or retention of stormwater. That would allow a developer to reduce the size or number of ponds."

Thomas Schueler, coordinator of the Chesapeake Stormwater Network, based in Baltimore, Md., recommends building "created wetlands" in the coastal plain either instead of ponds or as supplements to ponds.

A typical created wetland has two elements: a wide, thick bench of aquatic and terrestrial plants around its perimeter; and in the center a shallow, often boggy, sometimes dry retention area where soils can take up excess nutrients and other contaminants.

A created wetland does not have standing water year round. The idea is to increase the "residence time" of stormwater entering these systems so that wetland plants and soils have a chance to soak up contaminants. Created wetlands can be small but effective, says Schueler. An engineer could design a linear series of wetland "cells" that interrupt and complement new or existing stormwater pipe flows.

Wetland cells can be part of a larger "treatment train"—that is, a series of absorbing and filtering practices, including pervious pavements, rain gardens, and pond buffers.

Someday regulators might require developers to create artificial wetlands instead of building stormwater ponds for new developments.

It will take time before many coastal residents understand that digging a conventional, open-water pond is not the only way to manage localized stormwater runoff and, in fact, building a wetland is often a better alternative. As South Carolinians learn more about coastal ponds, they might see them in a more critical light and call for additional ways of managing stormwater.

DIRECT DRAINAGE. *Runoff pours into roadside catch basins, and then it is routed through subterranean pipes and discharged, unfiltered, into waterways.*
PHOTO/GRACE BEAHM

Reading and Web sites

Carolina Clear
www.clemson.edu/public/carolinaclear

Carolina Yards and Neighborhoods
www.clemson.edu/extension/natural_resources/water/carolina_yards

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Green Homes 101
www.dnr.sc.gov/marine/NERR/traininggreenhomes.html

Green Solutions to Pollution: Homeowner Practices for Managing Stormwater
www.dnr.sc.gov/marine/NERR/traininggarden.html

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Low-impact development brochure
www.scseagrant.org/pdf_files/lid_final_brochure.pdf

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Imitation–the sincerest form of flattery

How do you imitate something? First, you study it. You learn how it works, what makes it tick. Only then can you begin to replicate it.

That's the idea behind Sea Grant research in forested watersheds on South Carolina's coast. A team of scientists is studying how rainwater flows through these small watersheds that are characteristic of many undeveloped lands in the region.

When preparing to build on a new site, a developer must show that the rate of stormwater runoff from a project—a residential neighborhood or an office complex, for instance—will not be greater than that before development.

Engineers use equations and models to determine how much water flows through an undeveloped site and how much will flow through the same site after it has been developed. Ponds are frequently constructed, for instance, to slow down the rate of runoff after development occurs.

The problem, however, is that these equations are "too coarse," says Dan Hitchcock, a biosystems engineer with Clemson University. "They do not reflect the seasonal differences in water tables in many low-lying coastal areas."

DAN HITCHCOCK

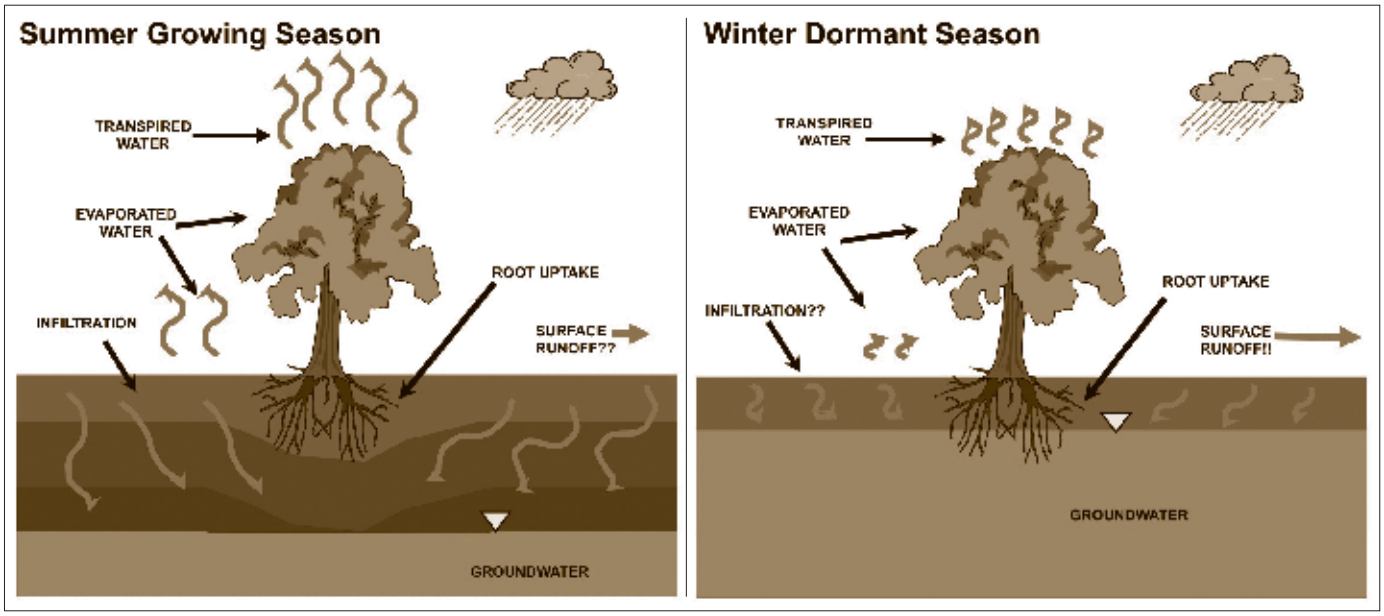
"How much water do trees take up and what is its seasonal effect? And then how much runoff is generated, and why?"

The lower coastal plain is a complex place to manage stormwater. During wet winters, for instance, the water table is often close to the surface because dormant trees are slow to take up water. Trees are crucial water pumps, and if those pumps are slow in responding, heavy rain must evaporate, run off the land, or be stored somewhere.

When it rains in a low-lying coastal area, how much water goes here rather than there? How much goes into the ground? How much is captured or taken up by vegetation? Evaporated back to the atmosphere? Runs off into creeks and marshes? How much water enters local streams from groundwater? How much enters creeks from surface runoff? How do all of these characteristics change from winter to summer?

That's what Sea Grant researchers from Clemson University's Baruch Institute of Coastal Ecology and Forest Science, College of Charleston, and U.S. Department of Agriculture Forest Service's Center for Forested Wetlands Research are studying: the seasonal and rainfall event-based mechanics of water budgets and stream flow at Bannockburn Plantation in Georgetown County and in the Francis Marion National Forest.

"We are working to understand



Many coastal forests have shallow groundwater. Trees and plants take up water in summer months (left panel), but in winter, most trees are dormant and evaporation is less (right panel), leaving the water table near the surface. High water tables restrict infiltration of rainwater into the soil and can lead to more surface water flow.
GRAPHIC/DAN HITCHCOCK/CLEMSON UNIVERSITY

LESSONS LEARNED. *Sea Grant researcher Dan Hitchcock, a Clemson University biosystems engineer, inspects sensors that provide information about stream water levels and water quality conditions. These measurements are being used to understand the seasonal variations and background conditions of an undeveloped coastal stream. The research also focuses on how stream levels and water quality conditions change before, during, and after storm events.*
PHOTO/GRACE BEAHM

how forest water budgets are related to shallow water tables," says Hitchcock. "When soils are saturated, such as in winter when trees are dormant, more runoff is generated than in summer. Infiltration—and therefore soil storage—is limited during these months. That potentially causes more stormwater quantity, which must be managed."

Adding to this complexity is that regulators, city and county officials, and other decision-makers increasingly are encouraging developers to consider innovative stormwater practices such as rain gardens and bioretention areas, created wetlands, or pervious pavements that hold, convey, and treat stormwater.

With innovative practices, developers could reduce the need for stormwater ponds while managing quantity and improving the quality of runoff.

But before builders can use these practices with confidence, they need more precise information about the water budget in South Carolina's coastal forests. That's hard to do. It would require a holistic, fine-grained, site-specific assessment of hydrology, soils, and vegetation. Furthermore, an onsite water budget is variable and complex as it considers precipitation, canopy interception, evaporation, transpiration, groundwater levels, percolation, soil storage, and stream flow or runoff.

Hitchcock and his colleagues are studying the forest water cycle in wet versus dry conditions, as well as in growing versus dormant seasons.

"We're monitoring the water table to see how it fluctuates seasonally," says Hitchcock. "How much water do trees take up and what is its seasonal effect? And then how much runoff is generated, and why?"

"If we can understand a site's water budget," Hitchcock adds, "then we can find ways to reduce stormwater volume by capturing it with rain barrels, storing for evaporation or plant uptake, preserving and restoring the natural vegetative landscape to re-use rainwater, and encouraging infiltration where appropriate," says Hitchcock. "If we reduce volume, then we can minimize water quality problems by keeping pollutant-laden stormwater from entering downstream ponds, creeks, and wetlands. We can accomplish much of this reduction by mimicking natural coastal processes."

NEWS & NOTES

2010 Environmental Awareness Award winner announced

Frank S. Holleman, III is the winner of the 2010 S.C. Environmental Awareness Award.

Frank S. Holleman, III
PHOTO/SUSAN FERRIS HILL/
S.C. SEA GRANT CONSORTIUM

A native of Seneca in Oconee County, Holleman received the award for his exceptional leadership, creativity, and passion for conservation and education efforts. Holleman's ability to work with landowners, forge new partnerships, and leverage public and private funding sources has led to conservation successes.

During his leadership at Naturaland Trust, one of the oldest land conservation trusts in the Southeast, Holleman was instrumental to the success of two projects: the Blue Wall Connection and Stumphouse Mountain.

The Blue Wall Connection—the southern anchor of the Mountain Bridge conservation initiative begun in the 1970s—links the Saluda watershed with conservation properties across the Blue Ridge escarpment in South Carolina.

Over the past five years, Holleman achieved the addition of 500 acres to the existing 30,000 acres of critical conservation lands to the area bordering Cherokee Foothills National Scenic Highway and the South Saluda River, including 9 tracts acquired by Naturaland Trust.

Holleman's second successful conservation effort is the Stumphouse Mountain project. This property, located in Oconee County, was close to being sold to a developer from Florida.

Holleman was the driving force in saving nearly 1,000 acres of mountain habitats, including Issaqueena Falls and other public recreation areas. He was able to bring together 1,118 private donors, state resources, a municipality, and non-governmental organizations to raise the $4.5 million dollars needed to protect this environmentally sensitive area.

The project paved the way for the establishment of the 442-acre Stumphouse Mountain Heritage Preserve now managed by the S.C. Department of Natural Resources.

The South Carolina General Assembly established the S.C. Environmental Awareness Award in 1992 to recognize outstanding contributions made toward the protection, conservation, and improvement of the state's natural resources.

Members of the awards committee represent the S.C. Sea Grant Consortium, S.C. Forestry Commission, S.C. Department of Natural Resources, and S.C. Department of Health and Environmental Control.

Coastal Heritage wins prestigious award

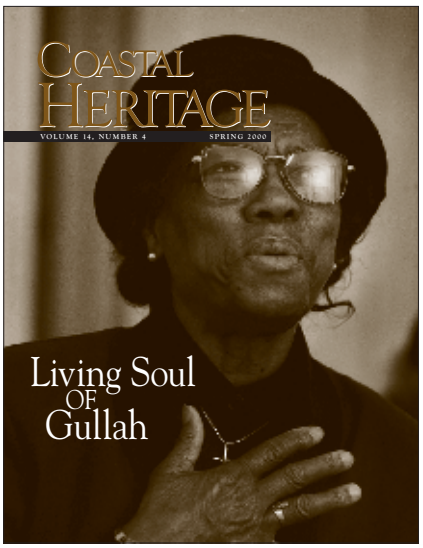
Coastal Heritage, a quarterly publication of the S.C. Sea Grant Consortium, received an Award of Excellence from the Society for Technical Communication Carolina chapter competition. The rigorous judging process was based on content and organization, copy-editing, visual design, and creativity.

Subscriptions to *Coastal Heritage* are available upon request by contacting Annette Dunmeyer at (843) 953-2078 or via e-mail at Annette.Dunmeyer@scseagrant.org.

Current and past issues are available online at www.scseagrant.org/Products.

Farewell, Wade Spees

After two decades of shooting photographs for *Coastal Heritage*, Wade Spees is hanging up his freelance camera, although he will continue as staff photographer for the Charleston *Post and Courier*.



PHOTO/WADE SPEES

This cover (above) for the Spring 2000 issue is one of his favorites among nearly 80 covers he produced. Thank you, Wade, for your creativity and sensitive eye over the past 20

NEWS & NOTES

years. We welcome another talented photographer, Grace Beahm, with this issue of *Coastal Heritage*, and we hope she'll join us for many more.

Cleanup volunteers needed

Join S.C. Sea Grant Consortium and S.C. Department of Natural Resources for the 23rd annual Beach Sweep/River Sweep on Saturday, September 17, 2011. Last year nearly 4,700 dedicated volunteers removed 24 tons of debris from our beaches, marshes, and waterways, but there is more work to be done.

Wando High School students volunteered on the Ben Sawyer causeway between Mt. Pleasant and Sullivan's Island during the 2010 Beach Sweep/River Sweep.
PHOTO/SUSAN FERRIS HILL/S.C. SEA GRANT CONSORTIUM

Beach Sweep/River Sweep—South Carolina's largest one-day cleanup—is held each year in conjunction with the Ocean Conservancy's International Coastal Cleanup. A list of coastal site captains and areas covered is available online at www.scseagrant.org/Content/?cid=49. Simply choose a site and contact the site captain directly to let them know you'd like to join their team. If you're interested in cleaning a needy area that is not listed, please contact Susan Ferris Hill, coastal coordinator, at (843) 953-2092 or Susan.Ferris.Hill@scseagrant.org. Volunteers who want to help inland may contact Bill Marshall at (803) 734-9096 or marshallb@dnr.sc.gov.

Restoration program engages students

South Carolina has more than 350,000 acres of salt marsh, but the pressures of development, natural processes, and other stresses can threaten this critical habitat. Now, a new Consortium education program—"From Seeds to Shoreline"—aims to help restore the salt marsh while educating students about the important functions of this habitat.

Elizabeth Vernon Bell, S.C. Sea Grant marine education specialist, initiated the pilot program in October 2010. Approximately 700 students from eight elementary, middle, and high schools in the Charleston, S.C., area are involved with the program, as well as one home school.

Students grow *Spartina alterniflora*, the smooth cordgrass that makes up salt marsh habitat in South Carolina, in a greenhouse, and then transplant young seedlings in areas that need restoration.

Among the restoration sites are areas around oyster reefs built by S.C. Department of Natural Resources' S.C. Oyster Restoration and Enhancement program. More than 10,000 plants have been seeded, the majority of which are transplanted, but some are kept at the schools so that students can test different variables such as exposure to different levels of sunlight, water, and temperatures. The program is aligned to South Carolina State Science Standards.

Students from Murray LaSaine Elementary School plant *Spartina alterniflora* seedlings at an oyster reef restoration site near Charleston Harbor.
PHOTO/SUSAN FERRIS HILL/S.C. SEA GRANT CONSORTIUM

"From Seeds to Shoreline" is funded by the S.C. Sea Grant Consortium, and collaborating partners include Clemson University's Coastal Research and Education Center, S.C. Department of Natural Resources, and the Ashley-Cooper Stormwater Education Consortium.

To learn more about this program, contact Elizabeth Vernon Bell at (843) 953-2084 or Elizabeth.Vernon@scseagrant.org. Information is also available online at www.scseagrant.org/Content/?cid=497, where a downloadable science journal template to record observations and measurements can be accessed.

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EBBS & FLOWS

9th International Conference on the Environmental Management of Enclosed Coastal Seas

Baltimore, Maryland
August 28-31, 2011

The purpose of this conference is to improve our ability to manage coastal seas in all their ecological, economic, and cultural dimensions. The conference will help cross barriers of discipline by bringing in experts and stakeholders from around the world. For more details, visit www.conference.ifas.ufl.edu/EMECS9 or contact Jhanna Gilbert at jhanna@ufl.edu or (352) 392-5930.

2011 Joint S.C. Marine Educators Association and Georgia Association of Marine Education Conference

Skidaway Island, Georgia
October 21-23, 2011

Join fellow educators and scientists for a weekend packed full of fun and educational events designed to celebrate our shared shoreline. Conference highlights include a sustainable seafood dinner, plenary panel, concurrent sessions, field trips, and live and silent auctions. The deadline to register is September 30. Contact Angela Bliss at acbliss@uga.edu or (912) 598-2387 or EV Bell at elizabeth.vernon@scseagrant.org or (843) 953-2084 for more information.

21st Biennial Conference of the Coastal and Estuarine Research Federation

Daytona Beach, Florida
November 6-10, 2011

This conference will highlight new findings and perspectives of the interactive dynamics of diverse ecosystems and human societies, and, in particular, explore how these dynamics can only be understood and managed when addressed on regional and global scales. Special sessions on socioeconomic drivers and responses will be included. For more information, visit www.sgmeet.com/cerf2011 or call (254) 776-3550.

Subscriptions are free upon request by contacting: Annette.Dunmeyer@scseagrant.org

ATTENTION SCHOOL TEACHERS! The S.C. Sea Grant Consortium has designed supplemental classroom resources for this and past issues of *Coastal Heritage* magazine. *Coastal Heritage Curriculum Connection*, written for K-12 educators and their students, is aligned with the South Carolina state standards for the appropriate grade levels. Includes standards-based inquiry questions to lead students through explorations of the topic discussed. *Curriculum Connection* is available on-line at www.scseagrant.org/education.